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of which a battery of nine Leyden jars was introduced. The Leyden jars are arranged in three batteries of three jars each, and the batteries connected in series.

The relative intensities and distinctive characters of the lines are represented by figures and letters, placed against the numbers in the Tables.

The spectrum, which extends from α to H , is divided, and forms two maps. The air-spectrum and the principal solar lines are placed at the top of each map, and below these the spectra of the following metals:—Sodium, potassium, calcium, barium, strontium, manganese, thallium, silver, tellurium, tin, iron, cadmium, antimony, gold, bismuth, mercury, cobalt, arsenic, lead, zinc, chromium, osmium, palladium, and platinum.

The lines of the air-spectrum are referred to the components of air to which they severally belong. An unexpected result was observed: two strong lines of the air-spectrum, one of them a double line, were seen to be common to the spectra of oxygen and nitrogen. These gases were obtained from different sources with identical results. The strong red line of the air-spectrum is shown to be due to the presence of aqueous vapour, and to coincide with the line of hydrogen. The carbonic acid in the air is not revealed by spectrum analysis.

Three pairs of lines and one band of haze are given in the sodium spectrum in addition to the double D line. As these might be due to impurities of the commercial sodium employed, the observation was confirmed by an amalgam of sodium prepared by the voltaic method from pure chloride of sodium. Two of these pairs of lines have been recognized in the spectrum of a saturated solution of pure nitrate of soda.

The two stronger pairs appear to agree in position with solar lines having the following numbers in Kirchhoff's scale:—864.4 and 867.1, and 1150.2 and 1154.2.

The spectrum from electrodes of potassium contains many new lines. For the spectra of calcium, lithium, and strontium, metallic calcium, lithium, and strontium were employed.

Barium was mapped from an amalgam of barium prepared by electricity from chloride of barium.

The following metals were employed in the form of electro-deposits upon platinum:—manganese, silver, tin, iron, cadmium, antimony, bismuth, cobalt, lead, zinc, and chromium. Care was taken that the other metals should be reliable for purity.

II. "On the Acids derivable from the Cyanides of the Oxy-radicals of the Di- and Tri-atomic Alcohols." By MAXWELL SIMPSON, A.B., M.B., F.R.S. Received November 7, 1863.

From every glycol it is possible to obtain two radicals—one monatomic, the other diatomic. From every glycerine it is possible to obtain three

radicals, which are respectively mono-, di- and tri-atomic. The compounds which these radicals form with the metalloids have been long since prepared and thoroughly studied. Our knowledge of the compounds which they form with cyanogen, whose behaviour so much resembles the metalloids, is not in so forward a state. At present we are only acquainted with a few of the cyanides of those of them which are destitute of oxygen, and the acids they form when submitted to the action of potash. The object of the present investigation is to extend our knowledge in this direction. With this view I propose to myself the following questions:— Is it possible to prepare also the cyanides of the oxy-radicals of glycol or glycerine? And if it be possible, is the action of potash on these cyanides analogous to its action on the ordinary cyanides? If the foregoing questions be answered in the affirmative, we shall then be able to obtain in this way, from every glycol, two, and from every glycerine three acids. A glance at the following Table will make this intelligible:—

Diatomic Alcohol (Glycol).

	Cyanide.	Acid.	
Chlorhydrine of Glycol $C_4H_5O_2Cl$	$C_4H_5O_2Cy$	$C_6H_6O_6$	Lactic?
Chloride of Ethylene $C_4H_4Cl_2$	$C_4H_4Cy_2$	$C_8H_6O_8$	Succinic* (bibasic).

Triatomic Alcohol (Glycerine).

	Cyanide.	Acid.	
Monochlorhydrine $C_6H_7O_4Cl$	$C_6H_7O_4Cy$	$C_8H_8O_8$	
Dichlorhydrine $C_6H_6O_4Cl_2$	$C_6H_6O_4Cy_2$	$C_{10}H_8O_{10}$	(Bibasic)
Trichlorhydrine $C_6H_5Cl_3$	$C_6H_5Cy_3$	$C_{12}H_8O_{12}$	(Tribasic)†

In the present paper I propose to take up the study of the acid $C_{10}H_8O_{10}$ in the glycerine series, which I succeeded in preparing in the following manner:—

A mixture of one equivalent of dichlorhydrine and two equivalents of pure cyanide of potassium, together with a quantity of alcohol, was maintained at the temperature of 100° Cent. for twenty-four hours in well-closed soda-water bottles. At the expiration of this time it was found that all the cyanide of potassium had been converted into chloride. The contents of the bottles were then filtered, and to the filtered liquor, which no doubt contained the body $C_6H_6O_4Cy_2$ in solution, solid potash was added. To this, heat was applied in such a manner as to prevent the escape of the alcohol by evaporation; and its application continued till ammonia ceased to be evolved. As soon as this was observed, the alcohol was distilled off, and the residue treated with nitric acid, which was afterwards removed by evaporation at a low temperature. The nitric acid accomplishes two objects: it destroys in a great measure the tarry matter which is present in large quantity, and at the same time sets free the

* Philosophical Transactions for 1861, p. 61.

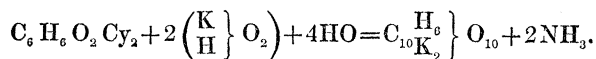
† Proceedings of the Royal Society, vol. xii. p. 236.

organic acid combined with the potash. The free acid was then separated from the nitrate of potash by means of alcohol.

On evaporating the alcohol a dark-coloured residue was obtained, which was dissolved in hot water and treated with chlorine. Finally a silver-salt of the acid was prepared by the following kind of fractional precipitation:—About one-third of the neutralized acid was first precipitated by the cautious addition of a solution of nitrate of silver. The liquor was then filtered, and the remainder of the acid was converted into the silver-salt. By these means I obtained, instead of a brown, a perfectly white precipitate, which yielded an acid in colourless crystals when decomposed by sulphuretted hydrogen. Dried at 100° Cent. these crystals gave on analysis numbers which agree tolerably well with the formula $C_{10}H_8O_{10}$, as will be seen from the following Table:—

Theory.		Experiment.	
		I.	II.
C_{10}	.... 40·54	41·62	41·61
H_8	.... 5·40	5·17	5·16
O_{10}	.... 54·06	—	—
<hr/>			
100·00			

These analyses were performed on specimens prepared at different times. This acid is soluble in water, alcohol, and ether. It has a pure acid taste. It melts at about 135° Cent., and at a higher temperature suffers decomposition. The free acid gives an abundant white precipitate with acetate of lead, soluble in strong acetic acid. It is not precipitated by lime-water. The neutralized acid yields a bulky white precipitate with corrosive sublimate, and a pale brown with perchloride of iron. Copper salts give a bluish-white precipitate. Chloride of barium is not affected. The formation of this acid may be explained by the following equation:—



I have also analyzed the silver-salt of this acid. As it suffers decomposition at the temperature of boiling water, I was obliged to effect its desiccation by placing it *in vacuo* over sulphuric acid. It is slightly soluble in water. The numbers it yielded on analysis agree very well with the formula $C_{10}\begin{smallmatrix} H_8 \\ Ag_2 \end{smallmatrix}O_{10}$:—

Theory.		Experiment.	
		I.	II.
C_{10}	.... 16·57	16·61	—
H_8	.... 1·65	1·39	—
O_{10}	.... 22·17	—	—
Ag_2	.... 59·61	—	60·67
<hr/>			
100·00			

The ether of this acid is readily prepared by passing hydrochloric acid gas through its solution in absolute alcohol. On evaporating the alcohol an oily residue was obtained, which was washed with a solution of carbonate of soda and distilled. The greater portion passed over between 295° and 300° Cent. The analysis of this portion gave numbers which

indicate the formula $C_{10} \frac{H_6}{(C_4 H_5)_2} O_{10}$:—

	Theory.	Experiment.	
		I.	II.
C_{18}	52.94	54.61	54.32
H_{18}	7.84	8.09	6.91
O_{10}	39.22	—	—
<hr/>			
100.00			

This ether suffers partial decomposition during distillation; hence the discrepancy between the theoretical and experimental numbers in the first analysis. The specimen which served for the second was not distilled at all, but simply purified by solution in ether. It is a colourless neutral oil with a very acid taste. It is somewhat soluble in water. Heated with solid potash it yields alcohol, and the acid is regenerated. I regret to say I have not succeeded in obtaining the cyanide ($C_6 H_6 O_2 Cy_2$), which generates this acid, in a state of purity.

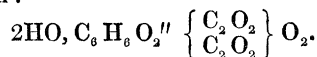
The compositions of the ether and silver-salt of this acid prove it to be bibasic. It is highly probable that the basicity of an acid produced in this way depends on the atomicity of the radical in the cyanide which generates it. If this be so, the cyanides of the mono-, di- and tri-atomic radicals of the glycols and glycerines should then yield by decomposition with potash respectively mono-, bi- and tri-basic acids. If it would be possible to prepare the acid $C_8 H_8 O_8$ from the cyanide $C_6 H_7 O_4 Cy$, it would be interesting to examine its bearing on this point. Would it prove mono-basic or bibasic?

This acid bears the same relation to pyrotartaric that malic bears to succinic acid :—

Succinic acid $C_4 H_4 O_4$ Pyrotartaric acid $C_{10} H_6 O_8$

Malic acid $C_5 H_6 O_{10}$ New acid $C_{10} H_8 O_{10}$

It has the composition of the homologue of malic acid. Whether it is actually the homologue of that acid or not I cannot yet say. I propose to call it oxy-pyrotartaric acid. Formulated according to the carbonic acid type it is thus written :—



We may now, I think, safely answer in the affirmative the questions put at the commencement of this Paper. The cyanides of the oxy-radicals of the di- and tri-atomic alcohols *can* be formed, and the action of the potash on these cyanides *is* analogous to its action on the ordinary cyanides.

The foregoing research was finished many months ago, but I delayed publishing it in the hope of being able to announce at the same time the formation of lactic acid by a similar process. I find, however, from the 'Annalen der Chemie und Pharmacie' of last month that I have been anticipated by Wislicenus, who has succeeded in forming lactic acid in the manner I have just described.

December 17, 1863.

Major-General SABINE, President, in the Chair.

The following communications were read:—

- I. "First Analysis of 177 Magnetic Storms, registered by the Magnetic Instruments in the Royal Observatory, Greenwich, from 1841 to 1857." By GEORGE BIDDELL AIRY, Astronomer Royal. Received November 28, 1863.

(Abstract.)

The author first refers to his paper in the Philosophical Transactions, 1863, "On the Diurnal Inequalities of Terrestrial Magnetism as deduced from Observations made at the Royal Observatory, Greenwich, from 1841 to 1857." These results were obtained by excluding the observations of certain days of great magnetic disturbance; it is the object of the present paper to investigate the results which can be deduced from these omitted days.

The author states his reasons for departing from methods of reduction which have been extensively used, insisting particularly on the necessity of treating every magnetic storm as a coherent whole. And he thinks that our attention ought to be given, in the first instance, to the devising of methods by which the complicated registers of each storm, separately considered, can be rendered manageable; and in the next place, to the discussion of the laws of disturbance which they may aid to reveal to us, and to the ascertaining of their effects on the general means in which they ought to be included.

The author then describes the numerical process (of very simple character) by which, when the photographic ordinates have been converted into numbers, any storm can be separated into two parts, one consisting of waves of long period, and the other consisting of irregularities of much more rapid recurrence. He uses the term "Fluctuation" in a technical sense, to denote the area of a wave-curve between the limits at which the wave-ordinate vanishes. The Waves, Fluctuations, and Irregularities, as inferred from separate treatment of each storm, constitute the materials from which the further results of the paper are derived.

Table I. exhibits the Algebraic Sum of Fluctuations for each storm, with the Algebraic Mean of Disturbances, and Tables II. and III. exhibit the